Ensuring Regular Cropping of Indiana Peaches

Final Report on research funded by the
Commissioner of Agriculture
through the Value Added Grants program

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October 2000

Summary

Spring applications of AVG and dormant oils, and fall applications of Ethrel were evaluated on mature peach trees. AVG applications effectively delayed bloom by 2-5 days. The most effective treatment was two applications of 2000 ppm AVG, which delayed bloom by almost 5 days. Repeat applications of AVG were more effective than the single dosage treatments. The 1000 ppm, repeat application delayed bloom by 4 days. A single application of 5000 ppm AVG resulted in severe phytotoxicity. The wetting agent levels were also varied and AVG applications were most effective in combination with 0.2% 'Sylgard'. AVG, apparently, delayed bloom by delaying bud development following the completion of rest. The dormant oil sprays were ineffective in achieving bloom delay. The specific leaf weight characteristics of the treated trees were not affected except for the 5000ppm AVG application, which reduced SLW. Fruit characteristics such as maturity, weight, and soluble sugar concentration were not affected by any of the spring applications (except for the 5000ppm AVG application, which was phytotoxic). Our studies indicate that AVG is effective in delaying bloom in peaches by up to 10 days. This has the potential to substantially increase peach yields in years with a late spring freeze. The next challenge with this research is to develop this information into a cost-effective treatment that can be used by fruit producers.

Ethrel achieved bloom delay but caused considerable damage to buds. Other research is examining methods to achieve bloom delay with Ethrel while avoiding the phytotoxicity effects.

Introduction

Peaches have the potential to be an extremely profitable crop for Indiana producers. There are few agricultural products that capture the attention of consumers more than fresh, ripe peaches. Most of the peaches produced in Indiana are sold directly to the consumer, at farm markets. In addition to being a profitable crop, peaches also provide a drawcard to the market that acts to promote the market and it's other produce. These factors combine to make peach production a valuable component to many Indiana fruit orchards.

Like most opportunities that offer good returns, peach production in Indiana is not easy or free of risk. The main source of risk for peach producers is cold. In peach, flowers are formed one year then overwinter in the bud prior to their emergence the following spring. Compared with a crop like apples, peaches are sensitive to cold conditions that can cause damage to the tree and limit production during two specific times of the year. Firstly, sustained temperatures below about 0°F can cause damage not only to the overwintering buds on a peach tree, but to the tree itself. Secondly, cold conditions during the spring can also cause reduction or total loss of crop. Damage from these 2 events may result in a crop of peaches only being borne in 2 or 3 years out of every five, which is an economically marginal situation. Peaches are at their most sensitive to the cold during flowering in the spring. Because peach flowering occurs earlier in the spring than apples,

there is a higher risk of frost at this time. If the time at which peach flowering occurs could be delayed, even by a few days, this may greatly lessen the risk posed by spring frosts. In many years this would help avoid freezing temperatures during the sensitive flowering phase and thereby prevent loss of a crop due to frost. In other years, such a delay in flowering would allow a partial crop to be carried whereas with no delay total crop failure may result. Therefore, such a delay in time of bloom offers the potential to reduce the risk associated with this high-value, high-risk crop.

Ethylene is a naturally produced plant hormone that has many and varied effects on plant growth and development. One of the roles that ethylene plays is in dormancy and the breaking of rest. Although it is clear that ethylene is involved in this process, the exact nature of it's control, or how ethylene levels may be manipulated to control bud break is not clear. In some studies, application of ethylene-releasing compounds have resulted in bloom delay in peaches however the response appears to be rather variable. Conversely, aminoethoxyvinylglycine (AVG), an inhibitor of ethylene production, has also been shown to delay bloom in some studies but not others. These studies differed in time of application, application rates and variety of peach used. Interactions between treatment and environmental conditions at the time of application may have also influenced the results obtained. Recently, a commercial formulation of AVG has been approved for use on some fruit crops, but for a different purpose. Therefore, we carried out a series of experiments with the following objectives:

1. To ascertain whether applications of the growth regulator AVG could delay the time of flowering of peach trees growing in a commercial setting
2. To determine the rates of AVG which have the maximum effect in delaying bloom
3. To examine the effects of AVG applications on the health of the trees
4. To investigate whether bloom delay treatments caused their effect by prolonging the time at which chilling is fulfilled

Materials and Methods

Studies were carried out on mature 'Redhaven' peach trees growing near Washington, IN and mature 'Newhaven' trees growing near West Lafayette, IN. Generally, large branches were selected, tagged, and randomly assigned to the experimental treatments. All experiments used one tagged branch on each of 8 replicate trees. Beginning a few days after treatment, the number of open flowers on each branch was counted. These counts were repeated at approximately 2 day intervals until all flowers were fully open. At this time, phytotoxicity (visual damage to the leaves) was assessed visually on a rating scale from 1-5, where 1=buds appearing dead and 5=buds appearing totally healthy. On several of our experiments, we also measured fruit size since large size is preferred in the marketplace and therefore any treatment that decreased fruit size would be viewed negatively by producers. Soluble solids concentration was measured using a digital refractometer - soluble solids concentration is essentially the same as sugar concentration in the juice of the fruit, and fruit with higher sugar levels are perceived as having superior taste.

Experiment 1 - high rates of AVG

This was conducted during the spring of 1998 and compared the following treatments:

1. control
2. water + wetting agent
3. 1000 ppm AVG
4. 2000 ppm AVG
5. 5000 ppm AVG
6. 10,000 ppm AVG

All spray applications were applied on March 27, when the trees were at the early bud swell stage of development. Treatments were applied with a high pressure handgun applied to run-off. Sylgard wetting agent was included in all spray applications, as recommended by the manufacturer of AVG.

Experiment 2 - lower rates of AVG

This was conducted during the spring of 2000 and compared the following treatments:

1. check (water + wetting agent)
2. 500 ppm AVG
3. 1000 ppm AVG
4. 1500 ppm AVG
5. 2000 ppm AVG

All spray applications were applied on 5 March, when the trees were at the bud swell stage of development. Treatments were applied with a high pressure handgun applied to run-off. Sylgard wetting agent was included in all spray applications, as recommended by the manufacturer of AVG.

Experiment 3 - multiple lower rates of AVG

This was conducted during the spring of 2000 and compared the following treatments:

1. check (water + wetting agent)
2. 2x500 ppm AVG
3. 2x1000 ppm AVG
4. 2x1500 ppm AVG
5. 2x2000 ppm AVG

All spray applications were applied on 5 March and 9 March, 2000, when the trees were at the bud swell stage of development. Treatments were applied with a high pressure handgun applied to run-off. Sylgard wetting agent was included in all spray applications, as recommended by the manufacturer of AVG.

Experiment 4 - comparison of single and multiple applications of AVG

This was conducted during the spring of 1999 and compared the following treatments:

1. check (water + wetting agent)
2. 1000 ppm AVG
3. 2000 ppm AVG
4. 2x1000 ppm AVG
5. 2x2000 ppm AVG

All spray applications were applied on 27 March and 30 March, 1999, which was before the time of the bud swell stage of development. Treatments were applied with a high pressure handgun applied to run-off. Sylgard wetting agent was included in all spray applications, as recommended by the manufacturer of AVG.

Experiment 5 - fall applied ethrel

Treatments were applied during the fall of 1999 to determine their effects on bud development the following spring. The treatments were:

1. check (water + wetting agent)
2. 75 ppm ethephon
3. 100 ppm ethephon
4. 150 ppm ethephon

All spray applications were applied on October 22, October 28, or November 4, 1999. On October 22, the trees were estimated to be at 30% leaf fall, 50% on October 28 and at 80% leaf fall on November 4. Treatments were applied with a high pressure handgun applied to run-off. Regulaid wetting agent was included in all spray applications, at 0.1%.

Experiment 6 - spring applied mineral oils

Treatments were applied during the spring of 1999 to determine their effects on bud development. The treatments were:

1. control - water only
2. 2% mineral spray oil
3. 5% mineral spray oil
4. 10% mineral spray oil
5. 2x2% mineral spray oil
6. 2x5% mineral spray oil

All spray applications were applied on 27 March, 1999, which was before the time of the bud swell stage of development. The second applications were applied on March 30, 1999 for those treatments receiving a double application. Treatments were applied with a high pressure handgun applied to run-off.

Results

Experiment 1 - high rates of AVG

The application of water plus wetting agent appeared to slightly advance the time of bloom, whereas the AVG slightly delayed bloom (Figure 1). The total amount of delay achieved however, was only about 2 days measured at 50% bloom. At 75% bloom, the delay was approximately 4 days. To achieve this delay, high rates of AVG were necessary. These rates were in a similar range to those shown previously to delay bloom in peaches, and our results were broadly similar.

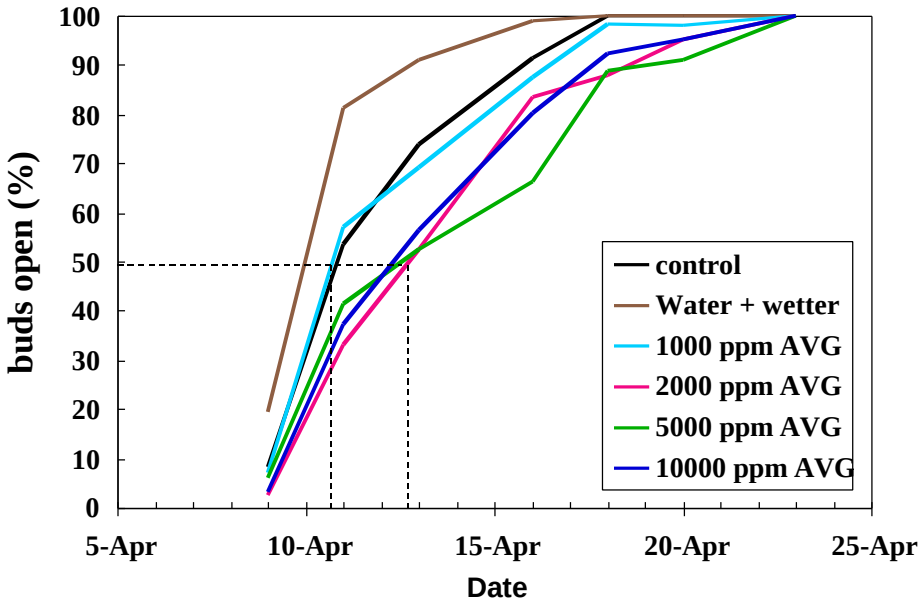

Figure 1. The development of flowering of 'Redhaven' peach following treatment with AVG. Treatments were applied on 27 March, 1998.

The application of water plus wetting agent only appeared to advance the flowering of the crop slightly, whereas applications containing wetting agent and AVG delayed flowering (Figure 1). The 1000 ppm treatment had little effect while the 2000 ppm and 10,000 ppm treatments both slightly delayed the time of flowering. The most delay was induced by the 5000 ppm AVG treatment, which delayed the time until 75% of flowers were open by 4 days. This delay was due to the AVG effect since water plus wetting agent alone actually advanced the time of flowering.

High application rates of AVG caused some damage to the trees. This was assessed visually, and the level of damage increased with increasing rates of AVG (Figure 2).

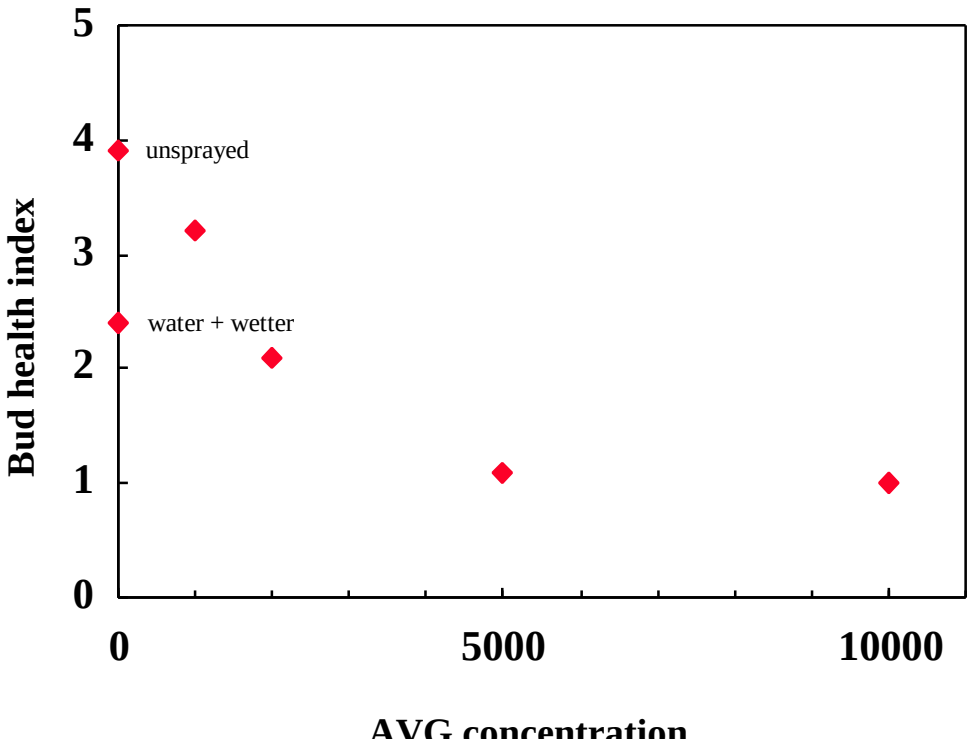

Figure 2. The apparent health of "Redhaven" peach branches following application with AVG. Bud health index was assessed visually based on a rating scale of 1=dead to 5=completely healthy. Treatments were applied on 27 March, 1998.

There was a marked difference in the level of damage between those 2 treatments receiving no AVG. Control branches received no applications at all, and appeared completely healthy. Branches receiving water plus wetter applications however did display some signs of damage (Figure 2). This suggests that perhaps the wetting agent itself was causing some of the damage but high rates of AVG also caused additional damage.

Experiment 2 - lower rates of AVG

Although we found some bloom delay as a result of high rates of AVG, high rates not only caused damage to buds and leaves, but would prove to be expensive in a commercial setting. Therefore lower rates were also assessed. During the 2000 growing season, lower rates were very effective in delaying bloom (Figure 3). At 50% bloom, the delay was approximately 8 days with the 2000 ppm treatment. Lower rates still delayed bloom, but the delay was less. For example, rates of 500 and 1000 ppm only delayed bloom by 4 days.

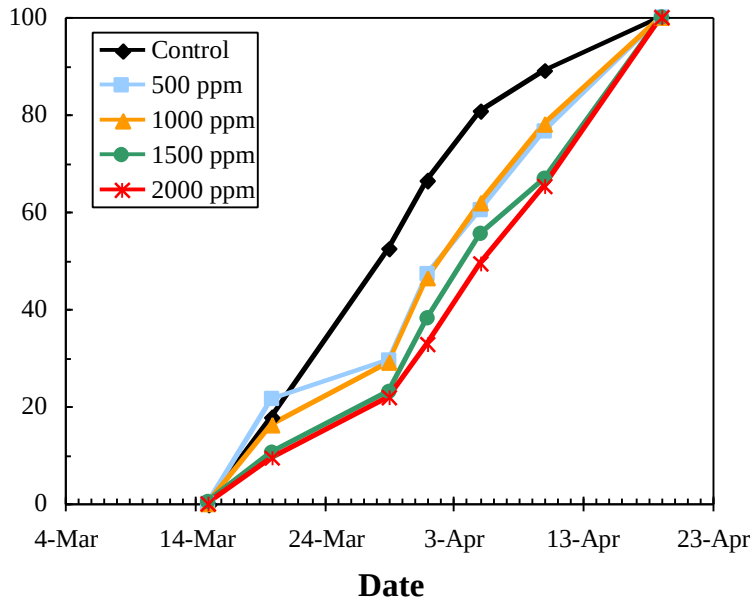

Figure 3. Flowering of 'Redhaven' peach as affected by various rates of AVG. Treatments were applied on 5 March, 2000 at which time the trees were at the bud swell stage of development.

Although there was a slight for higher rates of AVG to decrease fruit size, this was not statistically significant at $p<0.05$ (Figure 4). Likewise, the AVG treatments did not affect the soluble solids concentration of the fruit (Figure 5).

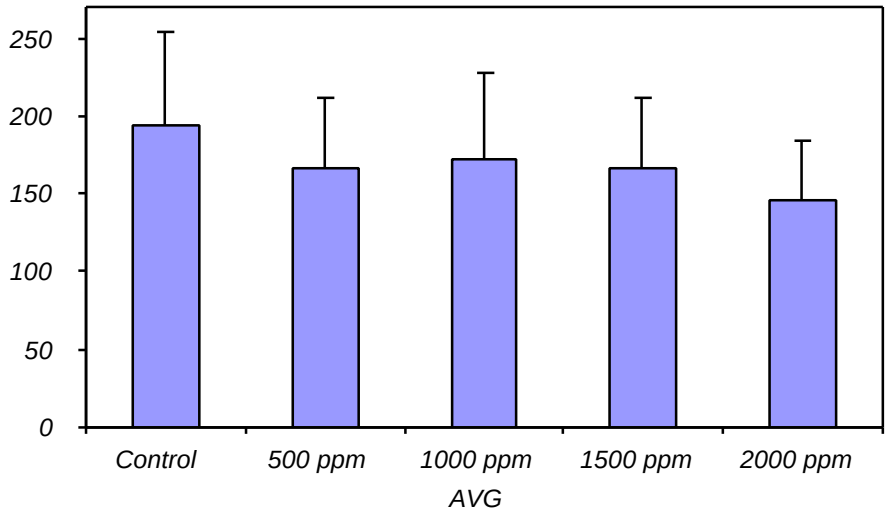

Figure 4. Fruit size of 'Redhaven' peach as affected by various rates of AVG. Treatments were applied on 5 March, 2000 at which time the trees were at the bud swell stage of development.

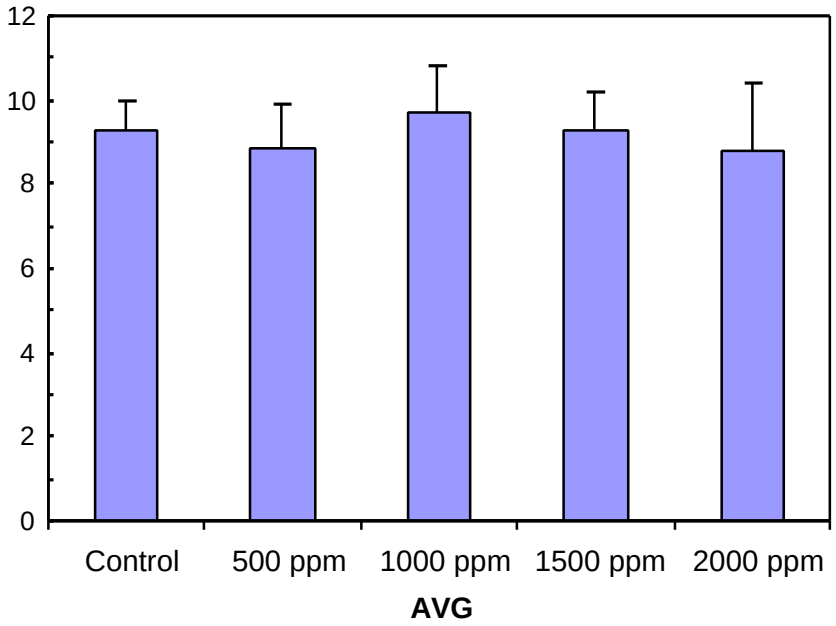

Figure 5. Fruit soluble solids concentration of 'Redhaven' peach as affected by various rates of AVG. Treatments were applied on 5 March, 2000 at which time the trees were at the bud swell stage of development.

Experiment 3 - multiple lower rates of AVG

More efficient use of the AVG compound may result from multiple applications. Two applications of a range of rates of AVG were assessed during the 2000 growing season. The most effective treatment was two applications each of 2000 ppm AVG, which delayed bloom by 10 days (Figure 6). Two applications of 500 or 1000 ppm AVG delayed bloom by 6 and 8 days respectively.

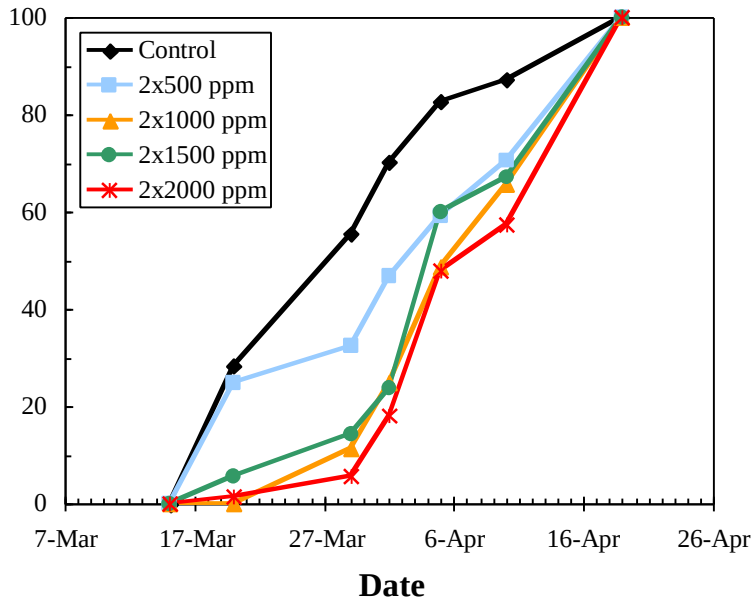

Figure 6. Flowering of 'Redhaven' peach as affected by two applications of various rates of AVG. Treatments were applied on 5 March, 2000 (at which time the trees were at the bud swell stage of development) and again on 9 March 2000.

Experiment 4 - comparison of single and multiple applications of AVG

Single and double applications of AVG were compared. It appeared that the same total amount of active ingredient but applied in two applications was more effective in delaying bloom than when applied in a single application. Once again, the 2000 ppm concentration proved to be the most effective.

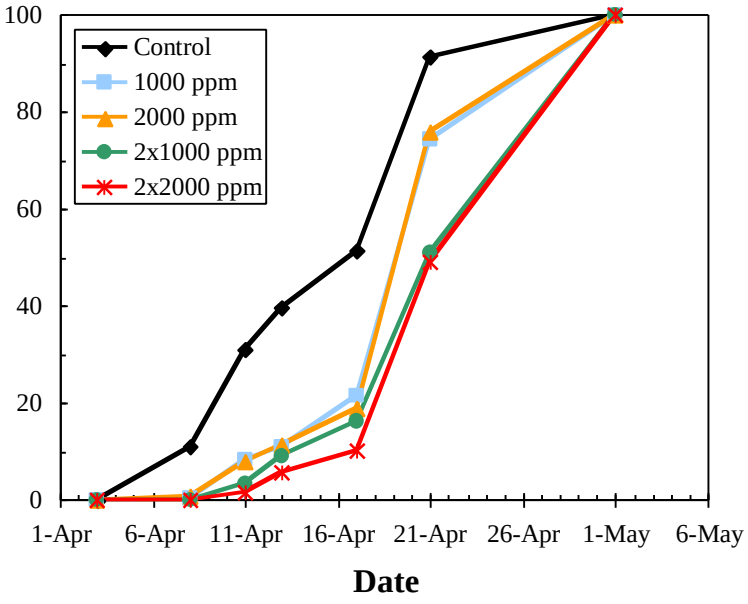

Figure 7. Flowering of 'Redhaven' peach as affected applications of AVG. Treatments were applied on 27 March, 1999 (which was prior to the time of bud swell) and again on 30 March 1999 for those treatments receiving repeat applications.

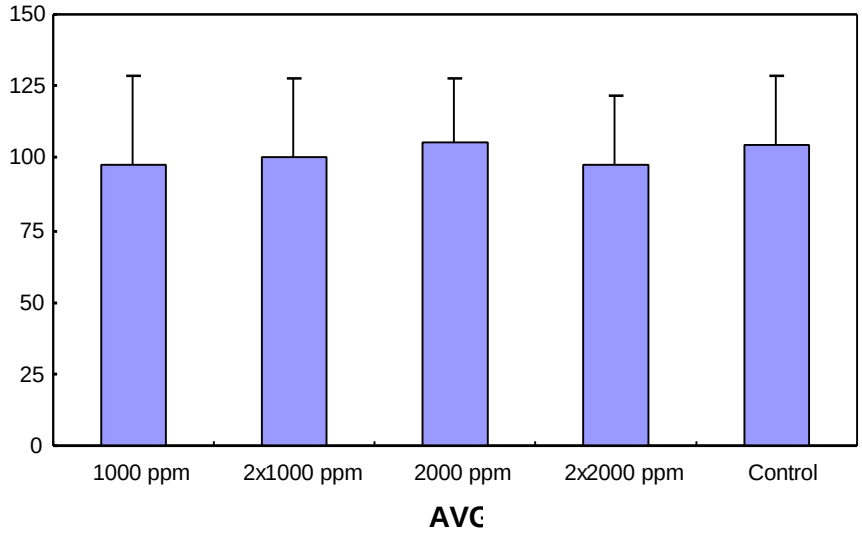

Figure 8. Fruit weight of 'Redhaven' peach as affected applications of AVG. Treatments were applied on 27 March, 1999 (which was prior to the time of bud swell) and again on 30 March 1999 for those treatments receiving repeat applications.

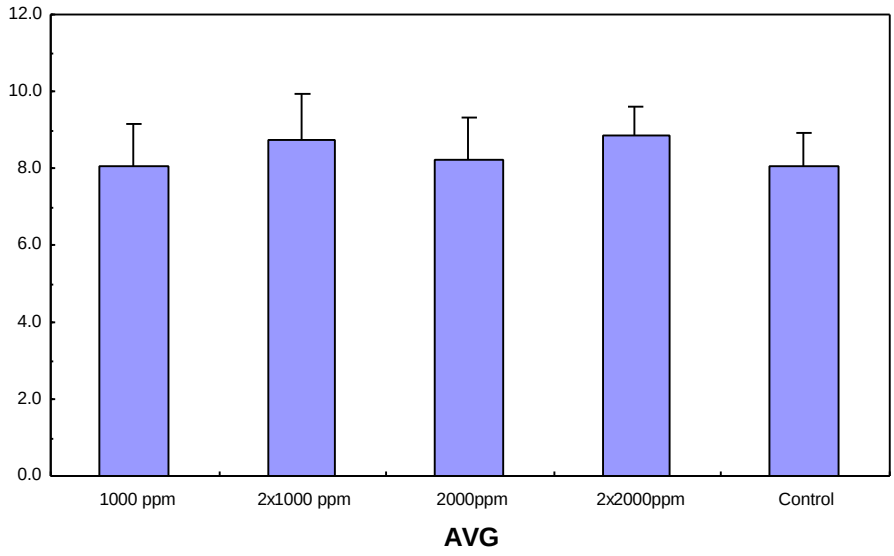

Figure 9. Soluble solids concentration of 'Redhaven' peach as affected applications of AVG. Treatments were applied on 27 March, 1999 (which was prior to the time of bud swell) and again on 30 March 1999 for those treatments receiving repeat applications.

Experiment 5 - fall applied Ethrel

Ethrel, when applied in the fall, had only a small effect on delaying bloom the following spring. The delays were 3 days or 1 day when applied on 22 October (Figure 10) or 28 October (Figure 11) respectively.

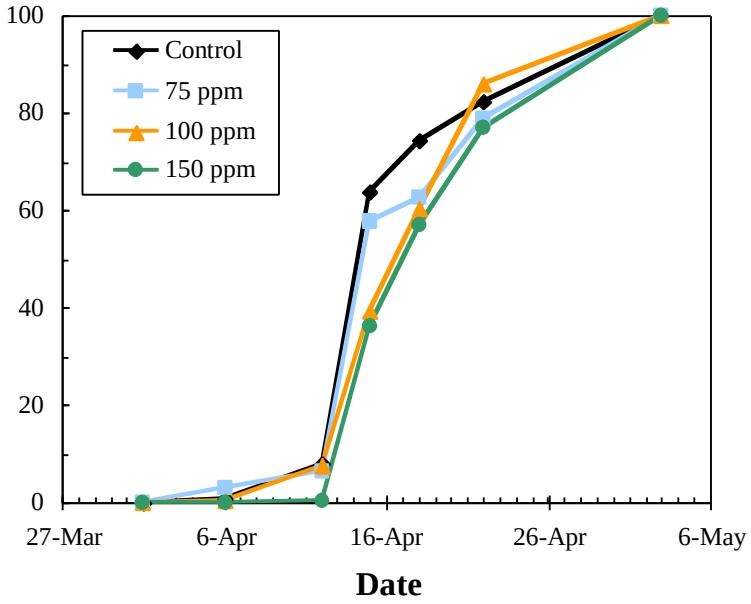

Figure 10. Flowering of 'Redhaven' peach as affected by Ethrel application the previous fall. Applications were made on 22 October 1999 and included 0.1% Regulaid as a wetting agent. Trees were at 30% leaf fall at the time of Ethrel applications.

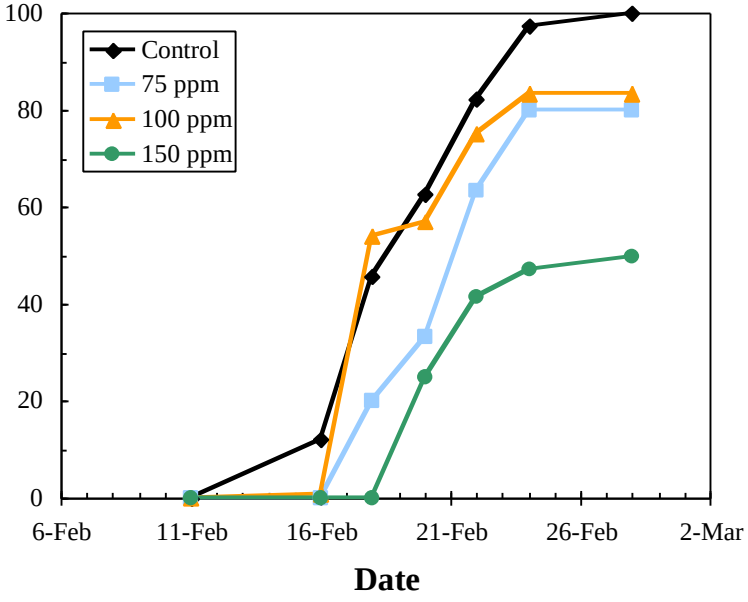

Figure 11. Flowering of 'Redhaven' peach as affected by Ethrel application the previous fall. Applications were made on 4 November 1999 and included 0.1% Regulaid as a wetting agent. Trees were at 80% leaf fall at the time of Ethrel applications.

Applications of Ethrel tended to decrease fruit weight (Figure 12) but had no effect on the soluble solids concentration of the fruit (Figure 13). High rates of Ethrel also resulted in severe phtotoxity to the trees (data not presented).

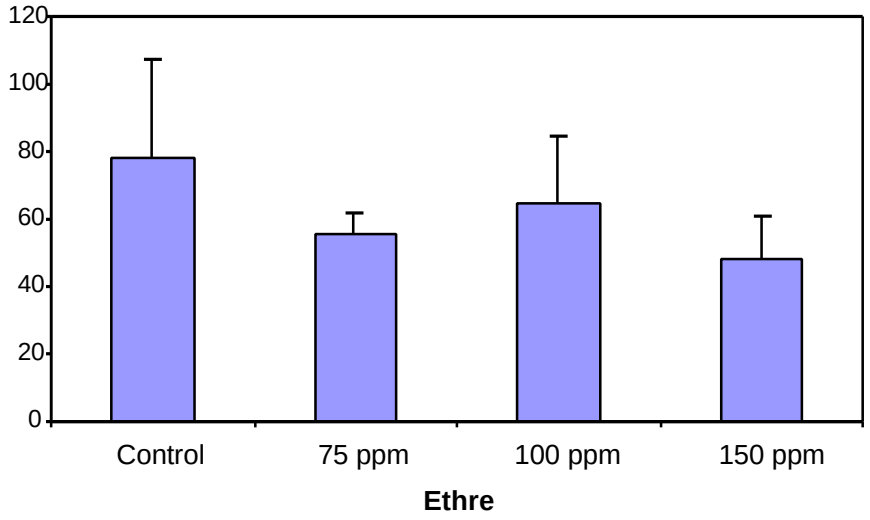

Figure 12. Fruit weight (g) of 'Redhaven' peach as affected by Ethrel application the previous fall. Applications were made on 28 October 1999 and included 0.1% Regulaid as a wetting agent. Trees were at 50% leaf fall at the time of Ethrel applications.

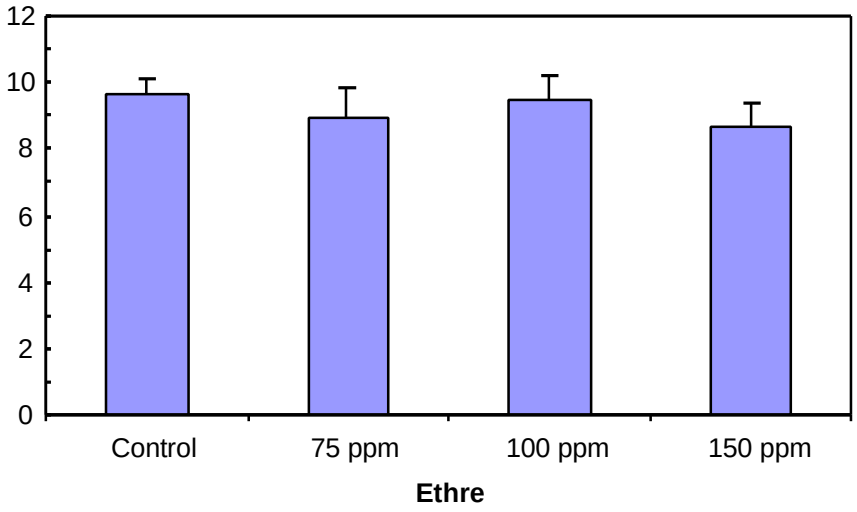

Figure 13. Soluble solids concentration (%) of 'Redhaven' peach as affected by Ethrel application the previous fall. Applications were made on 28 October 1999 and included 0.1% Regulaid as a wetting agent. Trees were at 50% leaf fall at the time of Ethrel applications.

Experiment 6 - spring applied mineral oils

The suggestion has been made in previous reports that applications of mineral oils in the spring may reduce respiration and delay bud development. In our study, application of oils had virtually no effect on the time of peach flowering (Figure 8).

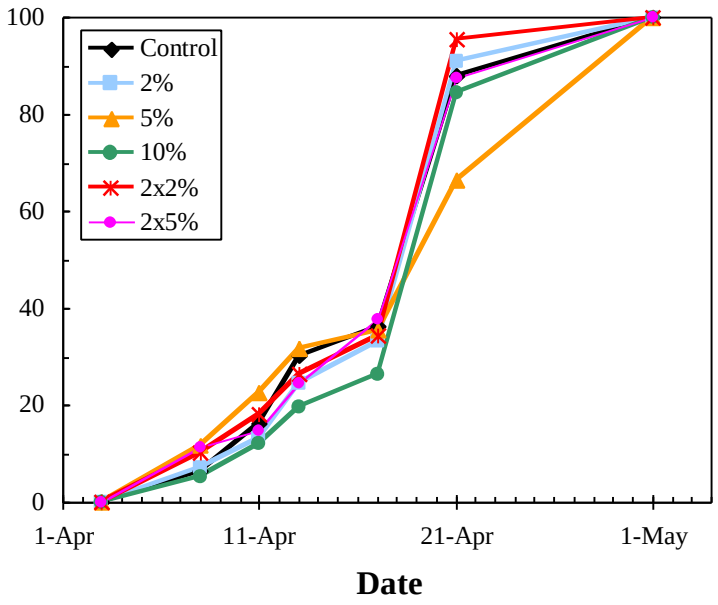

Figure 14. Effect of mineral oil applications on flowering of 'Redhaven' peach. Applications were made on 27 March, 1999 and again on 30 March, 1999 for those treatments receiving two applications.

Discussion

Application of AVG top peach trees was effective in achieving bloom delay. In 1999 the degree of bloom delay achieved as a result of AVG applications was slight, even using very high concentrations of AVG (Figures 1, 7). Rates higher than 2000 ppm AVG also caused severe damage to the buds on the peach trees (Figure 2). Experiments carried out the following year however, were much more effective (Figures 3,6). The experiments during the 2000 growing season were applied at a slightly later stage of development compared with the 1999 treatments, and this obviously warrants further study.

In the second year of experiments, we achieved up to 10 days delay in bloom, with two applications of 2000 ppm AVG (Figure 6). It would appear that using multiple applications is a method to increase the dosage of AVG while avoiding the phytotoxicity experienced with heavy single applications. These applications of AVG did not appear to have any negative effect of fruit quality, as measured by fruit weight and soluble solids concentration.

Ethrel was effective in achieving bloom delay when applied during the fall. However damage to buds was severe in some cases. For example, when Ethrel was applied at 80%

leaf fall (4 November 1999), on branches receiving 150 ppm Ethrel, only 50% of the buds open the following spring while the other half of the buds were dead.

Mineral oil applications were unsuccessful in achieving bloom delay (Figure 14). This result was disappointing since oils would be an inexpensive treatments for producers to use, and also have the potential to fit into an organic production system, if soybean or other "organic" oils could be shown to be effective.

Conclusions

The research reported here has shown that AVG applications can delay flowering in peaches under Indiana conditions. Unfortunately there are two barriers to adoption of this technology:

1. The high cost of treatment. The rates used in these studies would cost producers up to several thousand dollars per acre, and although peaches are a high value crop, the cost of this treatment is simply not cost effective.

2 The AVG product is currently not labeled for peaches. Given the small size of the industry and therefore relatively low potential chemical sales, it is unlikely the chemical companies would be willing to pursue registration of the product for this purpose.

Ethrel was also effective in delaying the time of peach flowering, but high rates caused damage to the buds. Other studies are currently underway to examine ways of applying Ethrel in a manner which still achieves bloom delay but which doesn't cause the same level of phytotoxicity. Such applications of Ethrel are likely to be cost effective, but are currently off-label, and therefore illegal for growers to use. Although the potential risk of the use of Ethrel to both applicators and consumers is extremely low, the regulatory landscape is such that the registrant is unlikely to pursue a label for Ethrel for this purpose.

Oil applications held much promise for several reasons, but in our studies did not result in a meaningful delay in bloom.